United States Patent [19]

Bengel et al.

[11] **Patent Number: 5,046,289**

[45] **Date of Patent: Sep. 10, 1991**

[54] **SYSTEM AND METHOD FOR CLEANING THE INNER SURFACE OF TUBULAR MEMBERS**

[75] Inventors: **Thomas G. Bengel; Edward A. Ray,** both of Plum Boro; **Phillip E. Miller,** Greensburg; **Frank I. Bauer,** Perry; **James Sejvar,** Murrysville, all of Pa.

[73] Assignee: **Westinghouse Electric Corp.,** Pittsburgh, Pa.

[21] Appl. No.: **307,103**

[22] Filed: **Feb. 6, 1989**

[51] **Int. Cl.**[5] **B24C 3/16;** B24C 9/00

[52] **U.S. Cl.** .... **51/411;** 51/410; 15/104.05; 15/104.1 R; 15/104.09

[58] **Field of Search** .... 51/411, 424, 429, 410; 118/DIG. 10, 317; 15/3.5, 104.09, 104.05, 104.03, 104.1 R

[56] **References Cited**

U.S. PATENT DOCUMENTS

1,045,742	11/1912	Pontani	51/411
1,952,848	3/1934	Eckler	51/411
2,089,597	8/1937	Carter	51/411
2,117,648	5/1938	Bottorf	51/411
2,399,544	4/1946	Danner	118/DIG. 10
3,058,137	10/1962	Doyle	51/411
3,106,491	10/1963	Leibner	118/DIG. 10
3,319,710	5/1967	Heeren et al.	165/95
3,446,666	5/1969	Bodine	134/1
3,451,091	6/1969	Wallace	15/104.6
3,615,817	10/1971	Jordan et al.	134/3
3,778,938	12/1973	Korn et al.	51/320
3,825,443	7/1974	Reilly	134/24
3,894,364	7/1975	Korn et al.	51/320
3,895,465	7/1975	Korn et al.	51/320
3,902,276	9/1975	Jarvis	51/411
4,219,976	9/1980	Burack et al.	51/411
4,314,427	2/1982	Stoltz	51/411
4,326,317	4/1982	Smith et al.	15/302
4,333,277	6/1982	Tasedan	51/425
4,374,462	2/1983	Wojcik et al.	51/411
4,483,205	11/1984	Bellaiche et al.	73/864.23
4,521,844	6/1985	Sturges, Jr. et al.	364/167
4,563,841	1/1986	Hart et al.	51/411
4,622,709	11/1986	Matsuda	15/4
4,715,324	12/1987	Muller et al.	122/381
4,720,369	1/1988	Cadaureille et al.	376/248
4,763,376	8/1988	Spurlock, Jr. et al.	15/104.09

FOREIGN PATENT DOCUMENTS

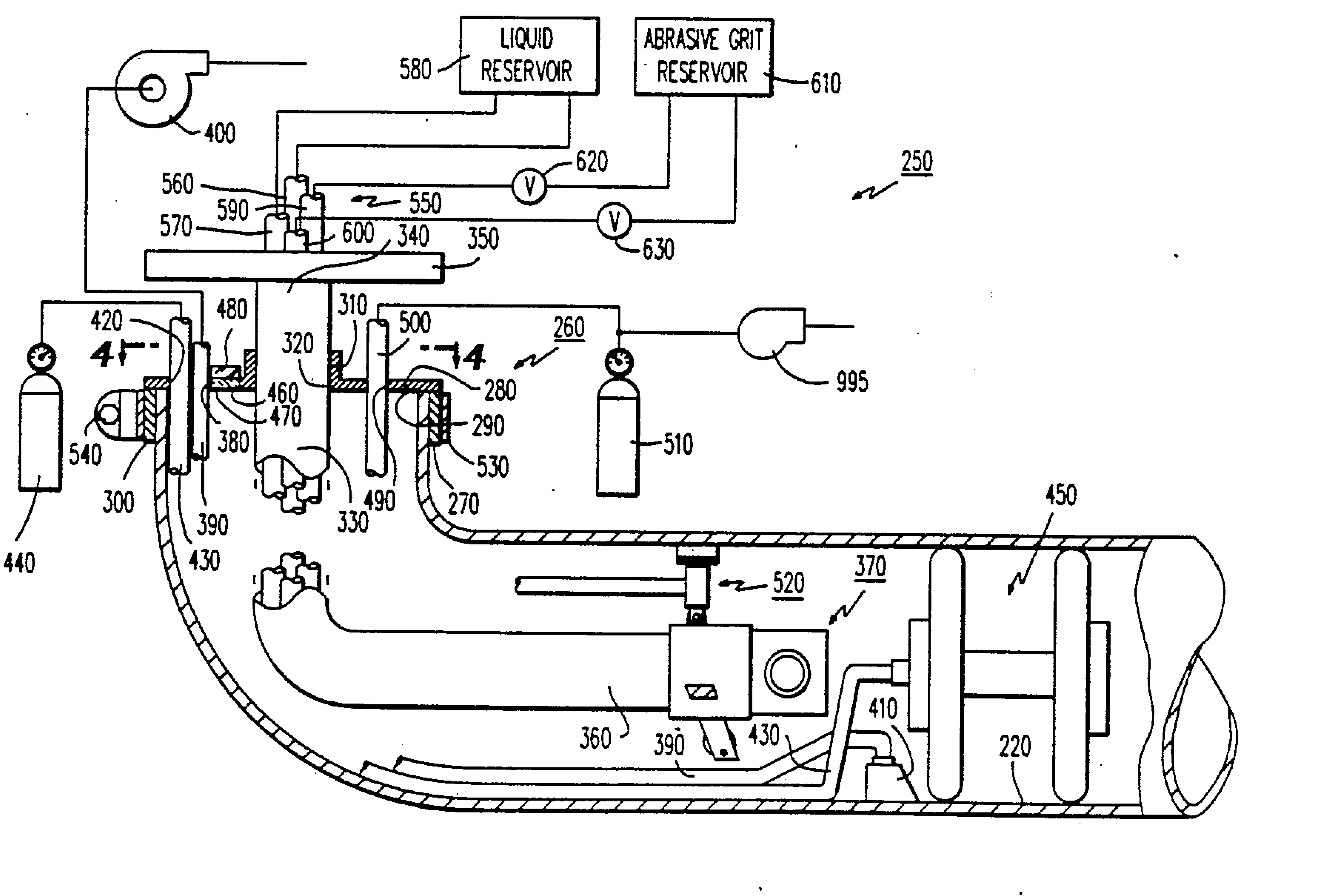
0221962	9/1988	Japan	51/290
0656330	6/1986	Switzerland	15/104.05
2200970	8/1988	United Kingdom	15/104.05

Primary Examiner—Robert A. Rose
Attorney, Agent, or Firm—Walter S. Stevens

[57] **ABSTRACT**

System and method for abrading radioactive contaminants from the inside surface of a pipe. The system includes a nozzle block capable of mixing a liquid and an abrasive grit into a suitable liquid-abrasive grit cleaning composition and impinging the cleaning composition against the inside surface of the pipe. The system further includes an inflatable torus-shaped seal for confining the liquid-abrasive grit cleaning composition to a predetermined portion of the inside surface of the pipe so that substantially all of the contaminants and cleaning composition can be suitably vacuumed from the surface.

15 Claims, 10 Drawing Sheets



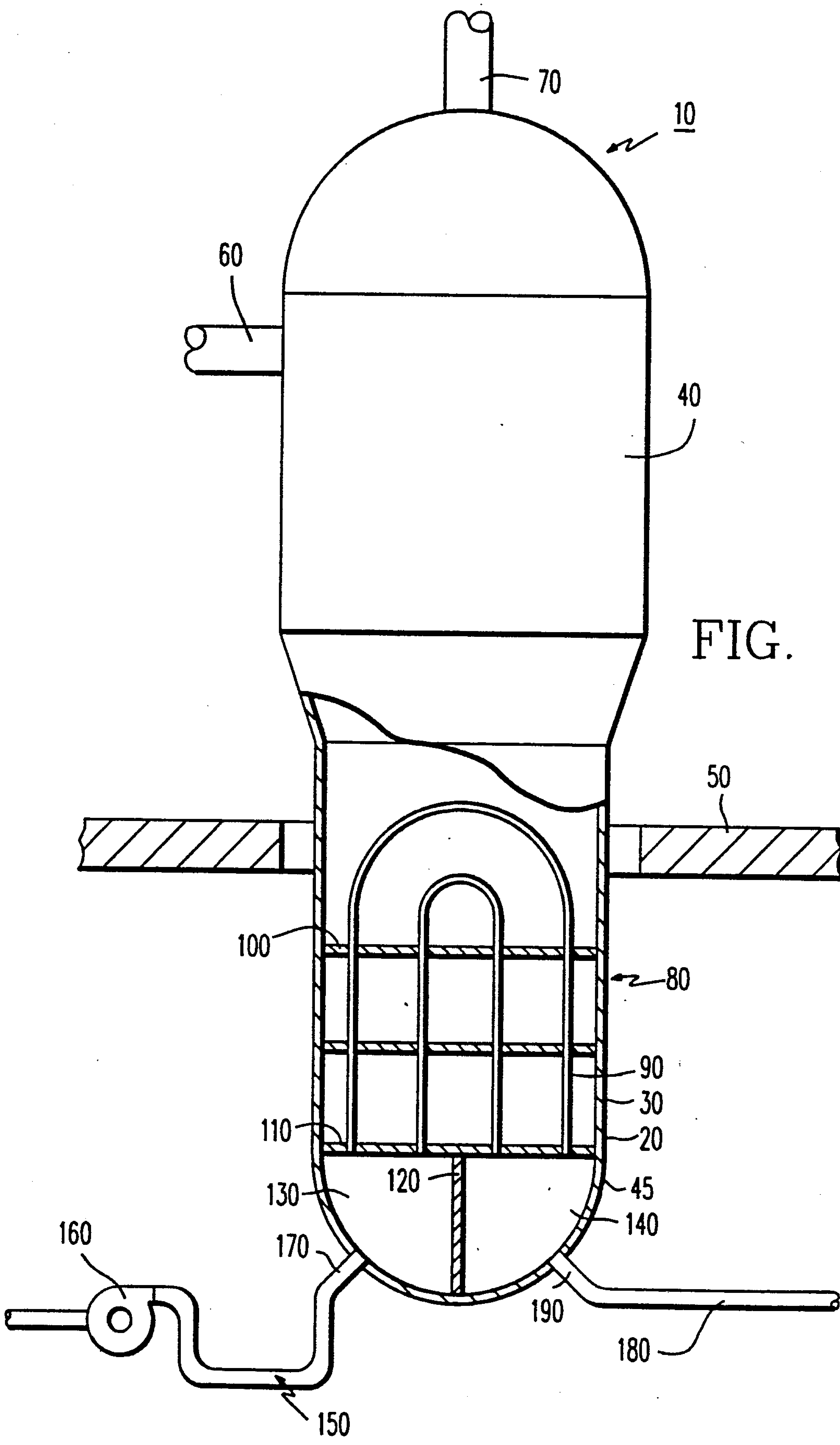

70
10
60
40
50
100
80
90
30
110
20
120
45
130
140
160
170
190
180
150

FIG. 1

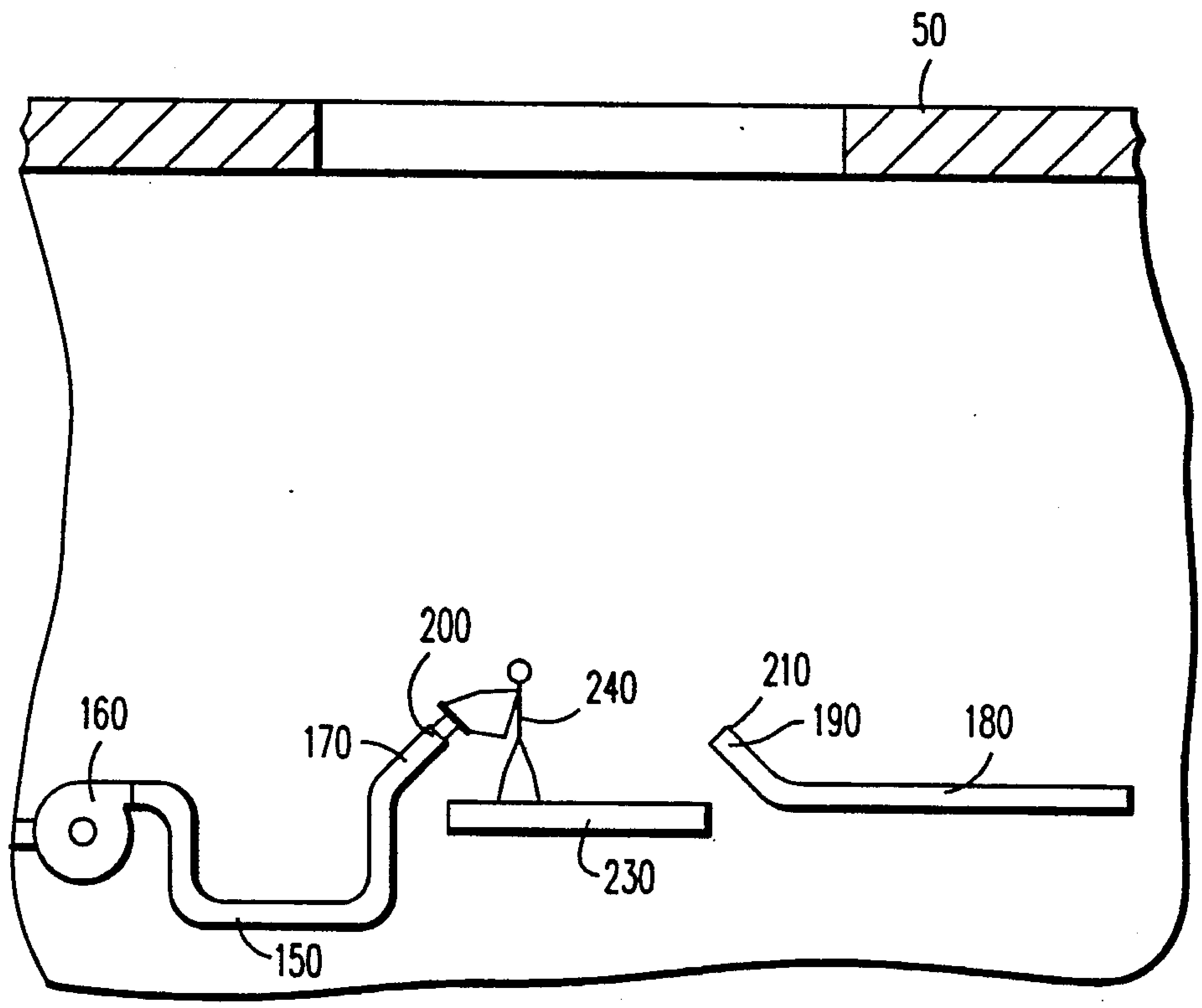
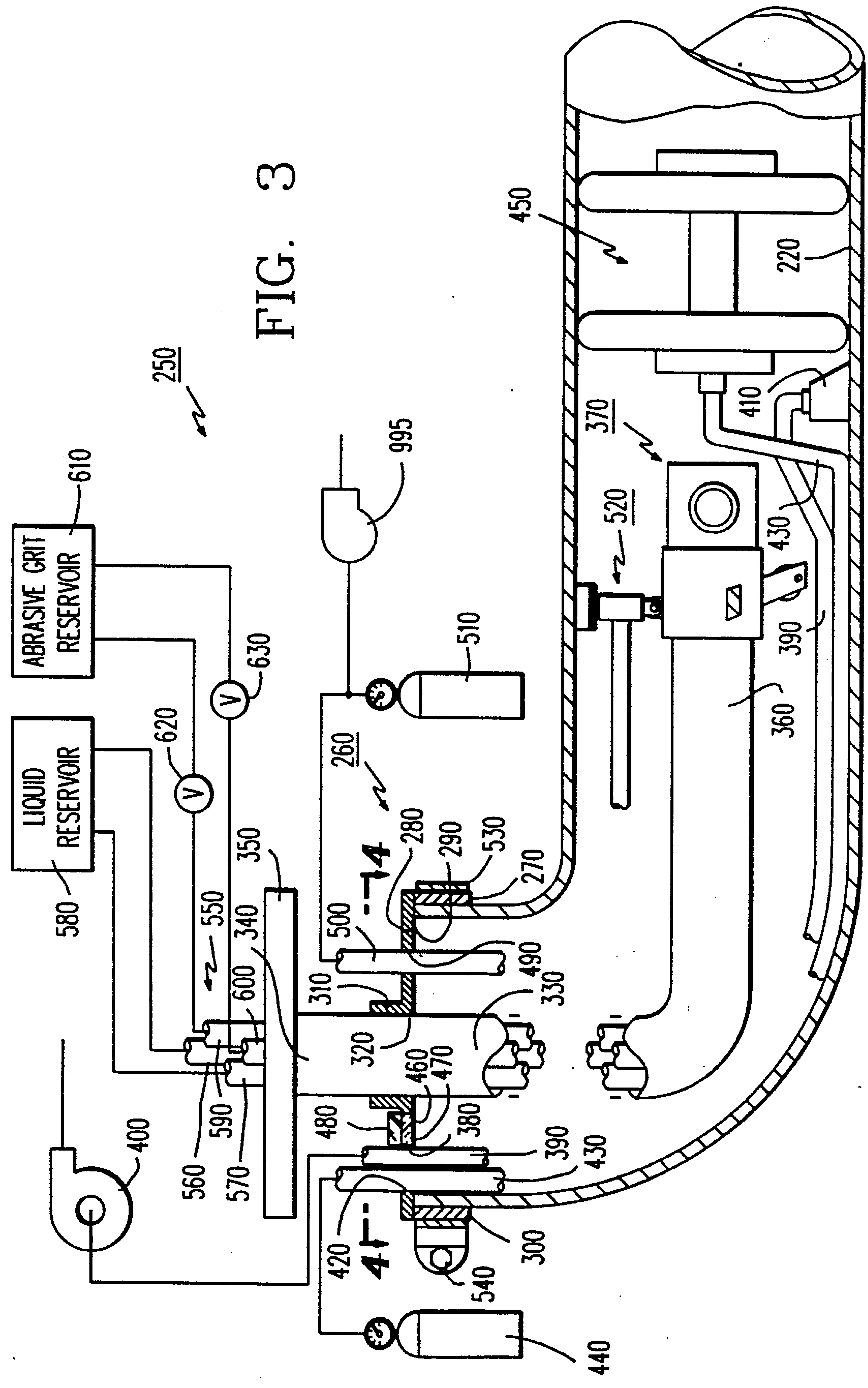


FIG. 2



ABRASIVE GRIT RESERVOIR
LIQUID RESERVOIR
V
V
250
260
370
520
610
620
630
580
550
560
590
570
600
340
350
310
320
330
500
490
280
290
530
270
460
470
480
380
390
430
420
300
540
440
400
995
510
360
410
450
220
4
4

FIG. 3

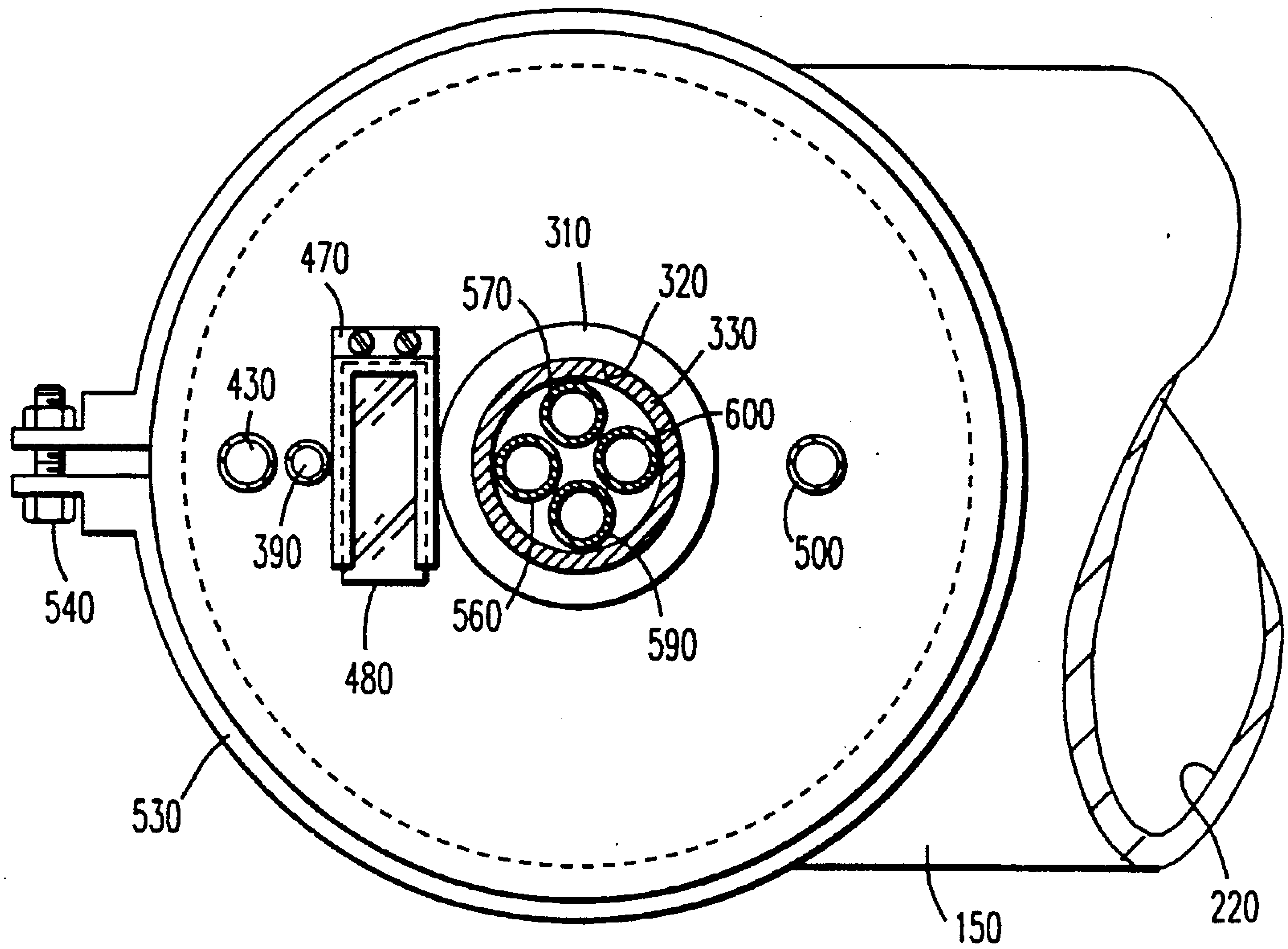


FIG. 4

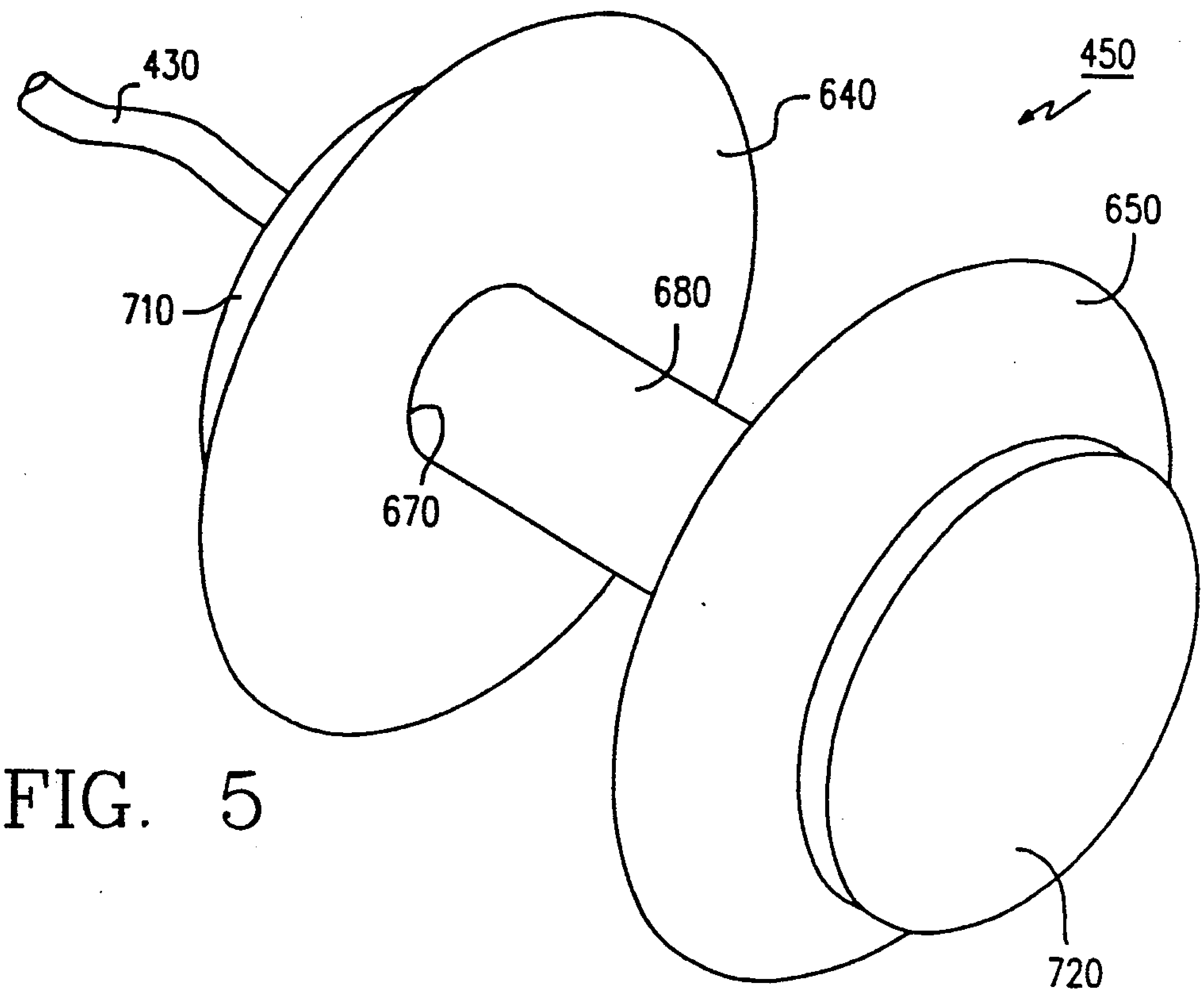


FIG. 5

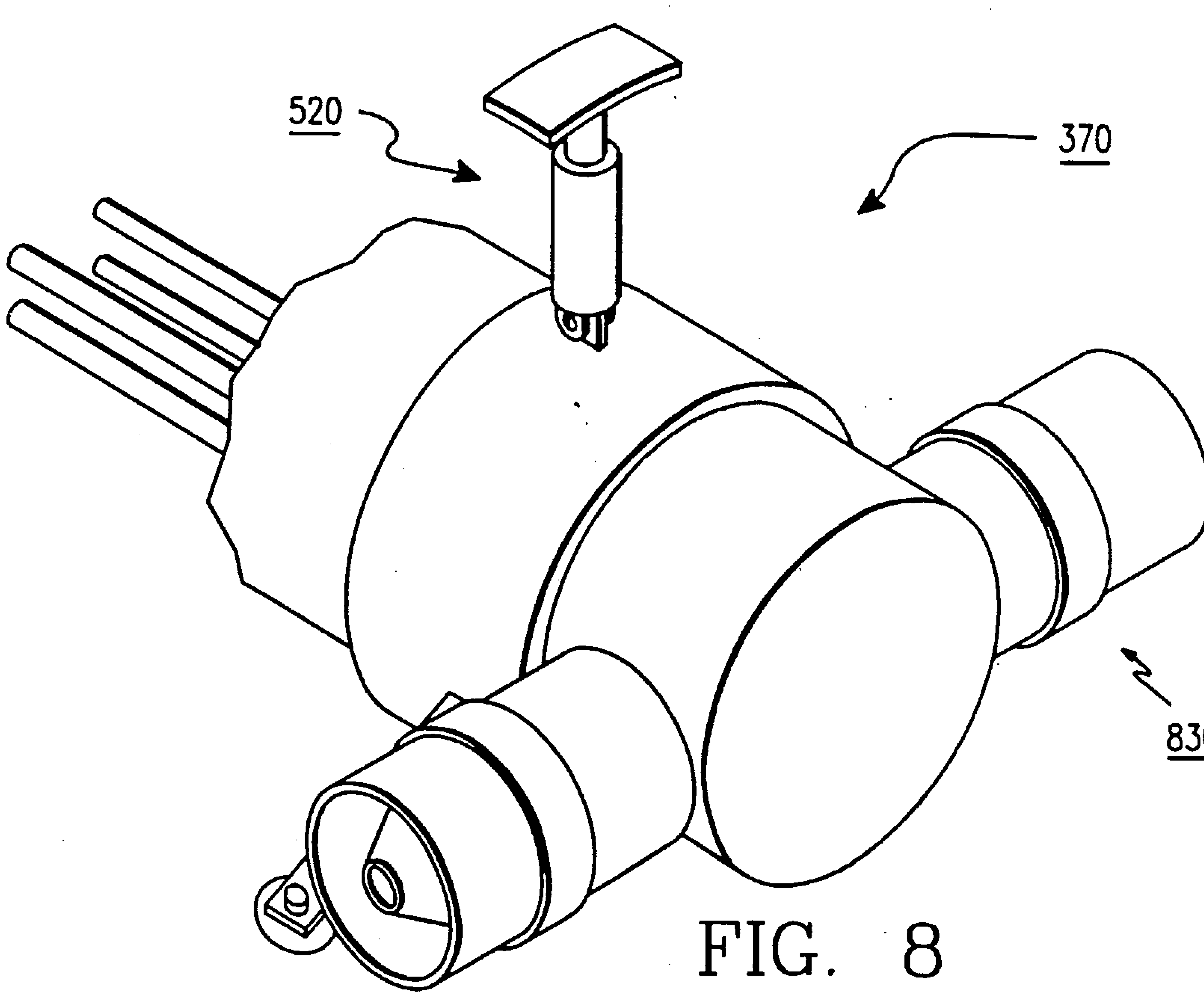


FIG. 8

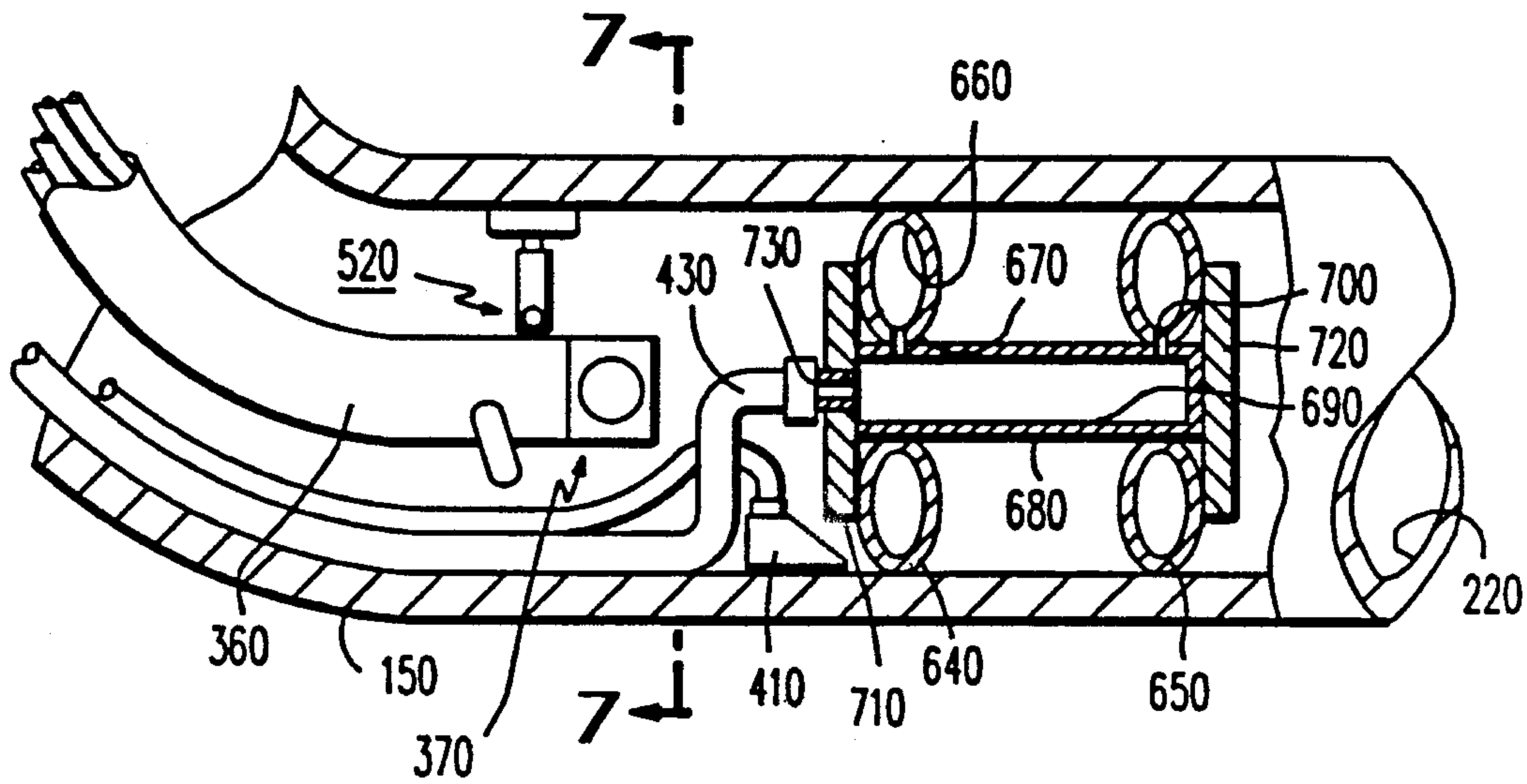

7
660
520
730
430
670
700
720
690
680
220
360
150
410
710
640
650
7
370

FIG. 6

FIG. 7

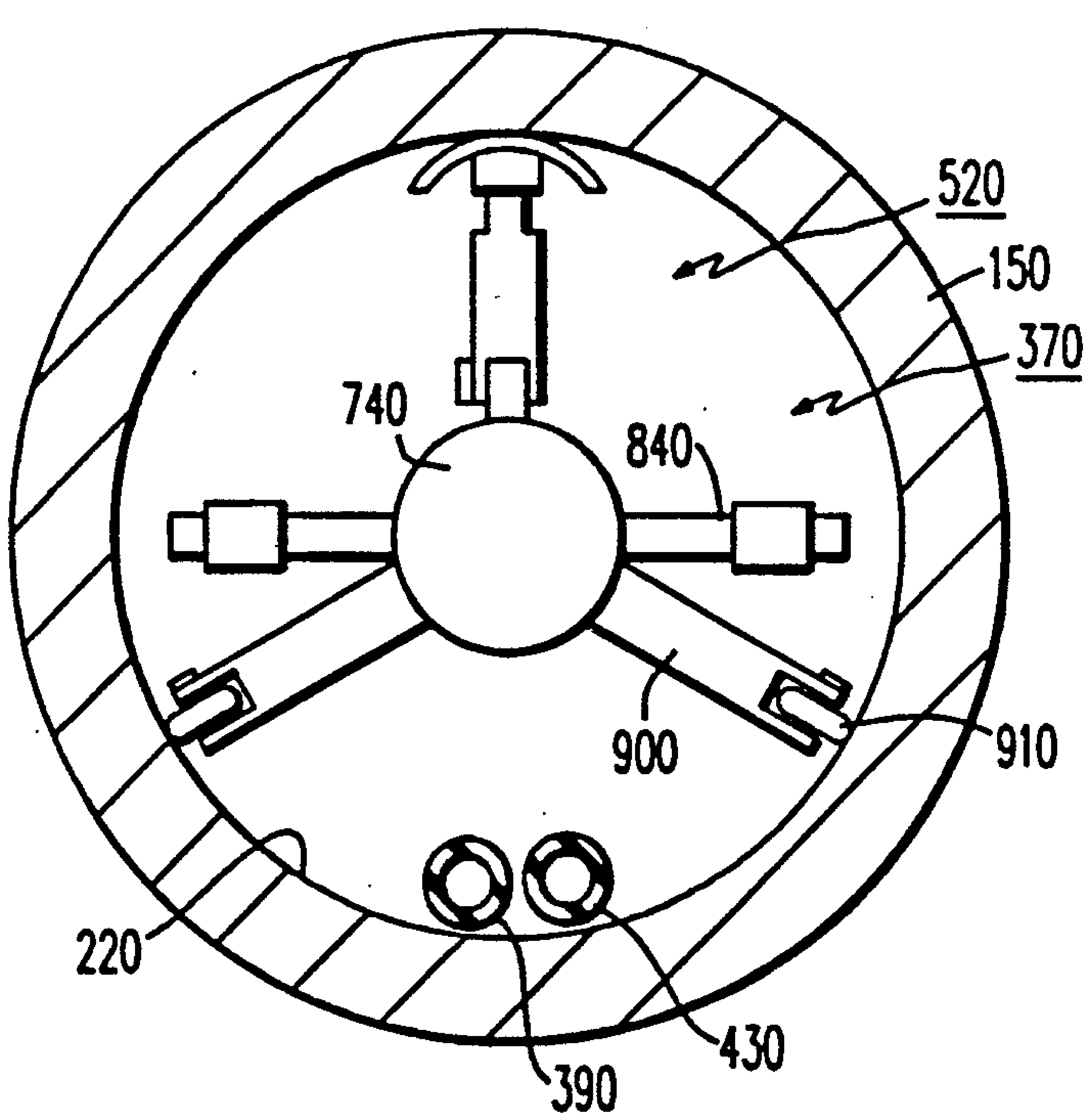

520
150
370
740
840
900
910
220
430
390

FIG. 9

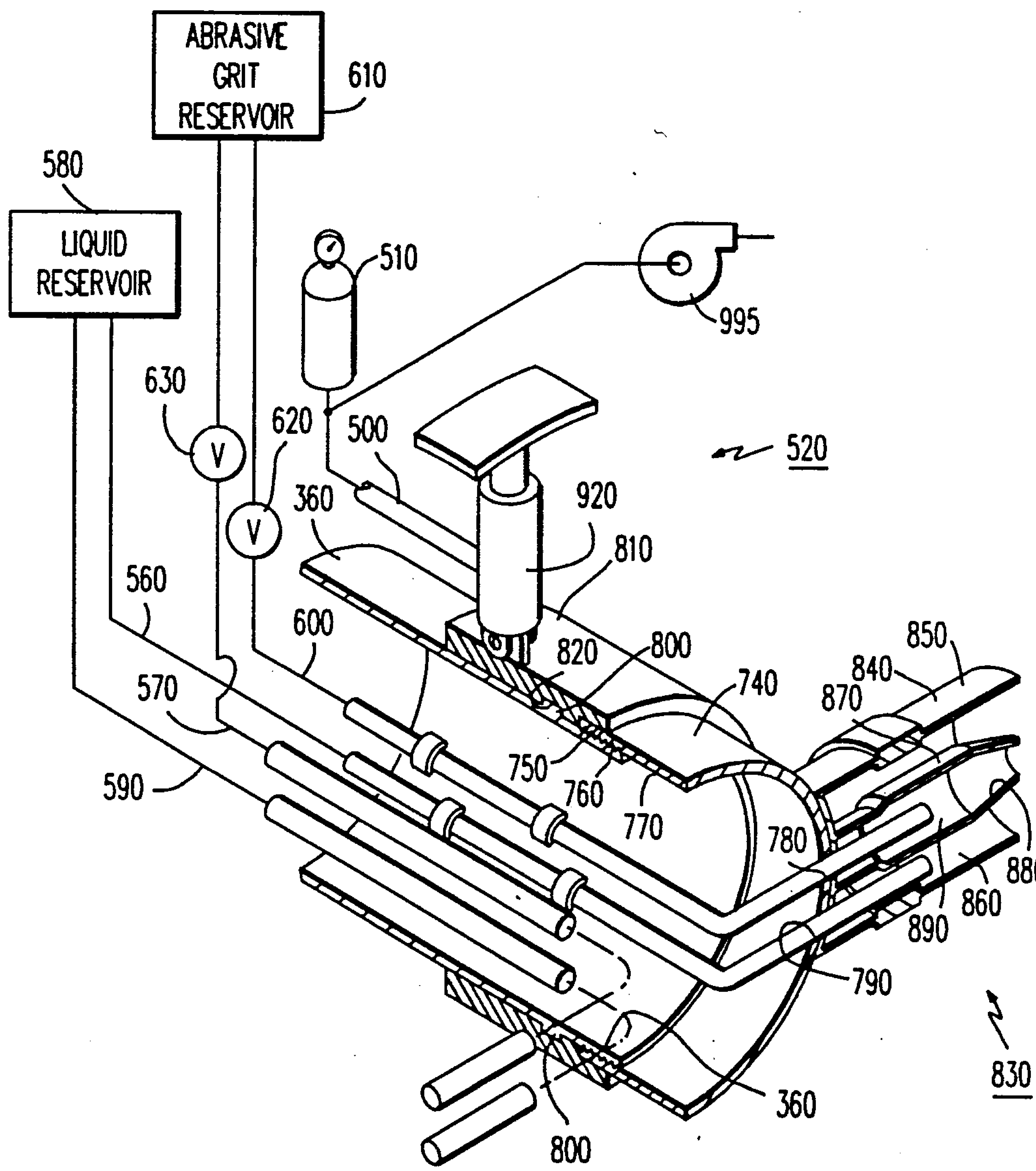

ABRASIVE GRIT RESERVOIR
610
580
LIQUID RESERVOIR
510
995
630
V
620
V
500
520
360
920
810
560
600
820
800
850
840
870
740
570
750
760
770
780
880
590
860
890
790
830
360
800

FIG. 10

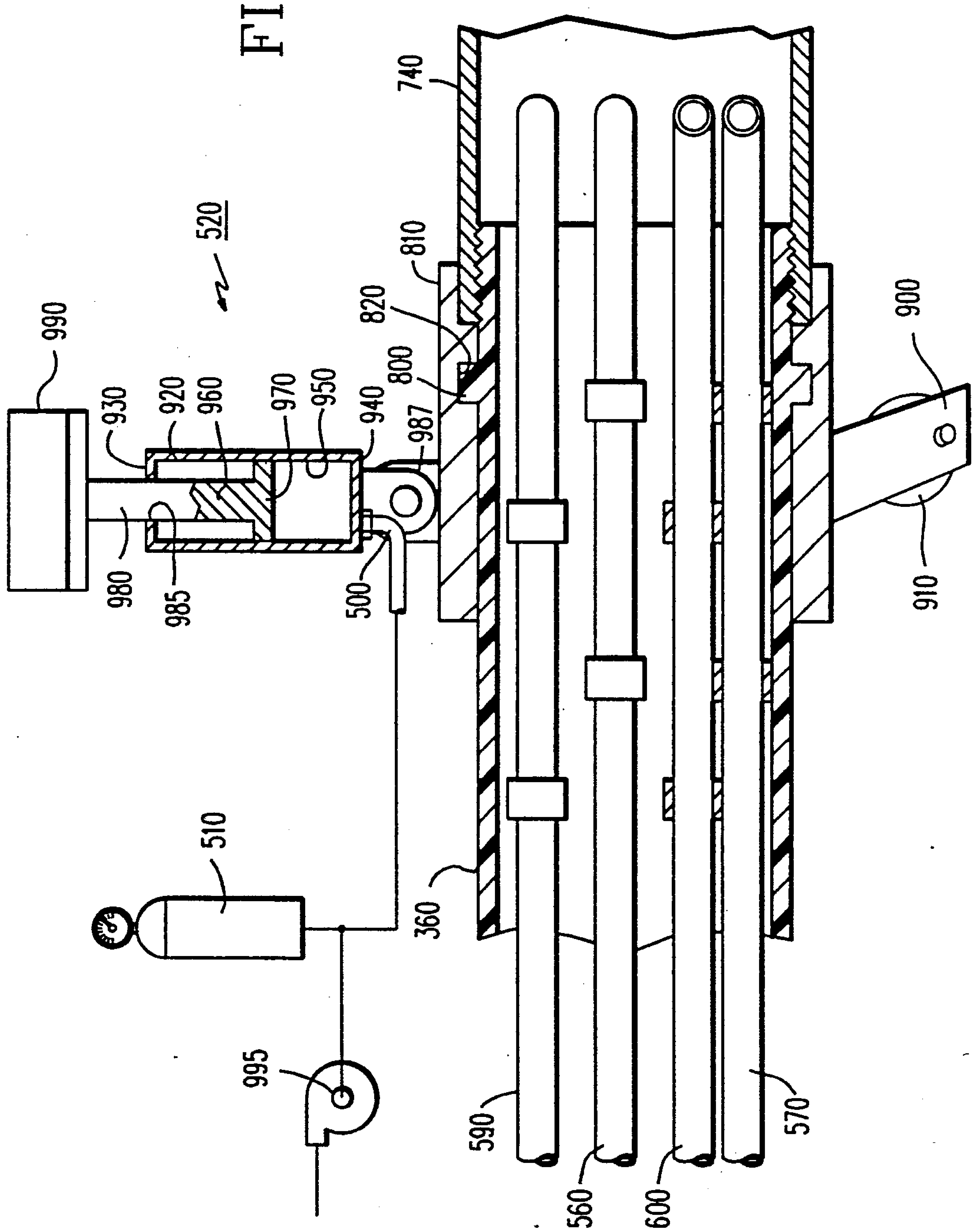
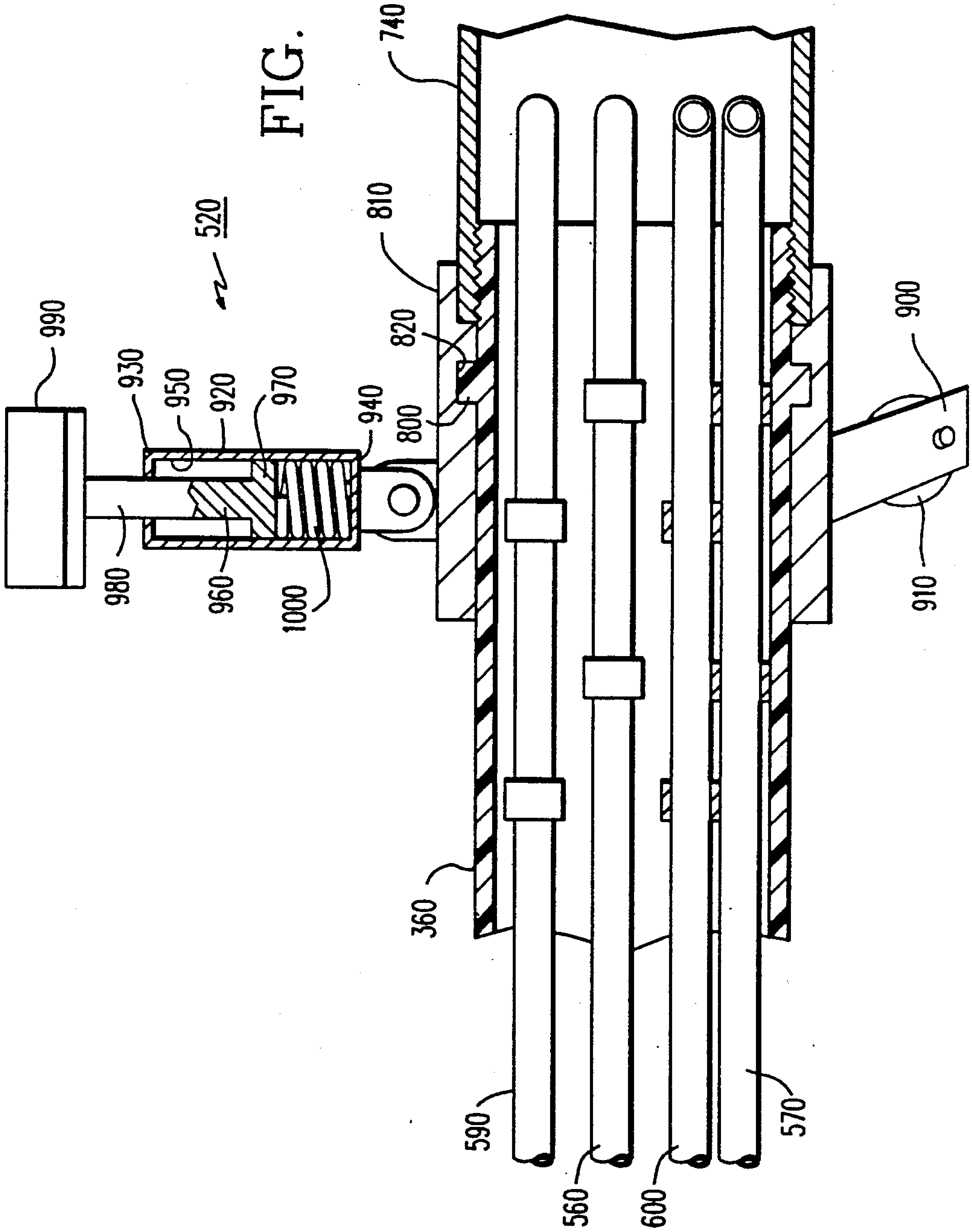

520
990
930
920
960
970
950
940
800
820
810
740
987
980
985
500
900
910
510
360
995
590
560
600
570

FIG. 11


520
740
810
820
800
990
930
950
920
970
940
980
960
1000
900
910
360
590
560
600
570

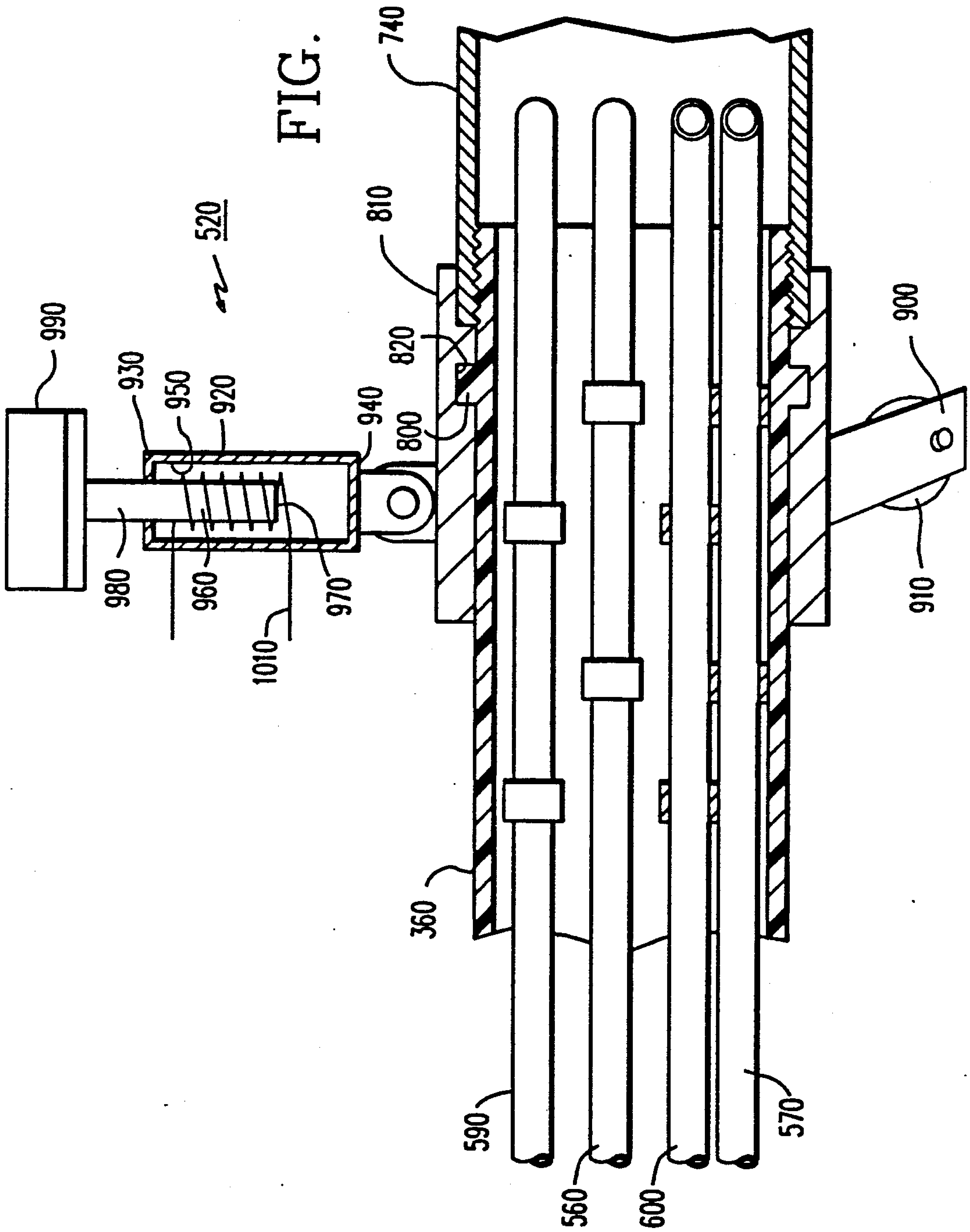

740
810
820
800
520
990
930
950
920
940
980
960
970
1010
900
910
360
590
560
600
570

FIG. 12

SYSTEM AND METHOD FOR CLEANING THE INNER SURFACE OF TUBULAR MEMBERS

BACKGROUND OF THE INVENTION

This invention generally relates to systems and methods for cleaning the inner surface of tubular members and more particularly relates to a system and a method for abrading radioactive contaminants from the inside surface of a pipe.

A nuclear reactor power plant produces heat which is transferred to a liquid moderator that in turn circulates through at least one heat exchanger or steam generator for producing steam. The steam produced in the steam generator is then transferred to a turbine-generator for generating electricity in a manner well known in the art of nuclear power production. However, the circulating liquid moderator typically has dissolved and suspended radioactive solids therein. These highly radioactive solids usually are radioactive corrosion products formed from within the reactor, the plant piping system and the plant equipment through which the moderator circulates. During operation of the nuclear reactor, these radioactive corrosion products may form a sediment which will deposit on the inside surfaces of the plant piping system and plant equipment. In order to safely perform some types of maintenance (e.g., steam generator replacement) on the nuclear reactor power plant these highly radioactive deposits should be removed.

Of course, replacing a steam generator requires severing the end of the piping connected thereto and removing the steam generator. Thus, one end of the piping is exposed because it has been severed, and the other end of the piping is inaccessible because the other end of the piping remains connected to plant equipment. In any case, after the steam generator is removed, the radiation field emitting through the exposed pipe stubs, due to the radioactive sediments on the inside surface of the piping, may expose maintenance workers to an undesirable level of radiation. For example, the radiation field emitting through the pipe stubs may expose maintenance workers to the maximum allowable radiation dosage in only a few minutes of working time. Using many maintenance workers, wherein the radiation dose to any one worker is relatively low, is prohibitively expensive. Therefore, it is desirable to reduce the radiation dosage rate to a value that is as low as reasonably achievable in order to reduce the radiation exposure to maintenance workers who are performing the steam generator replacement. Cleaning of highly radioactive sediments from the inside surfaces of the piping, particularly sediments on the inside surface of the piping near the pipe stubs, will reduce the radiation exposure to maintenance workers performing the steam generator replacement. Moreover, it is important to suitably confine and remove the deposits cleaned from the inside surface so that the deposits are not transported through the piping to other reactor components where such deposits may contaminate and damage these other components. Therefore, one problem in the art has been to suitably remove the radioactive sediments from the inside surfaces of the piping so that the radiation fields emitting through the pipe stubs are reduced to a value that is as low as reasonably achievable. Another problem in the art has been to suitably confine and then suction the removed deposits and cleaning composition so that the removed deposits and cleaning composition are not transported through the piping to other reactor components.

A method of chemically decontaminating radioactive surfaces is disclosed by U.S. Pat. No. 3,615,817 issued Oct. 26, 1971, in the name of William T. Jordan, et al. entitled "Method of Decontaminating Radioactive Metal Surfaces". The Jordan, et al. patent discloses a method wherein decontamination is attained by employing a foam containing a chemical reagent which will chemically attack the radioactive contamination on the surface. Although the Jordan, et al. patent discloses a method of chemically decontaminating radioactive surfaces, this patent does not appear to disclose an apparatus for chemically decontaminating radioactive surfaces. Moreover, the Jordan, et al. patent does not appear to disclose either an apparatus or a method for mechanically decontaminating radioactive surfaces.

In general, chemical decontamination of nuclear power plant components, such as piping, is unacceptable for various reasons. For example, radioactive contamination is usually strongly bonded to the inner surface of the component; therefore, chemical decontamination may not adequately remove the contamination. In addition, transport of such chemicals to components other than the component being cleaned may lead to undesirable chemical attack and damage to other portions of the power plant. Therefore, another problem in the art has been to positively clean the inner surface of power plant components without the use of chemicals.

An apparatus for mechanically, rather than chemically, decontaminating a heat exchange tube is disclosed by U.S. Pat. No. 4,326,317 issued Apr. 27, 1982, in the name of Edward H. Smith, et al. entitled "Decontamination Apparatus" and assigned to the Westinghouse Electric Corporation. The Smith, et al. patent discloses a decontamination apparatus comprising a rotatable hone and brush capable of being inserted into a heat exchange tube of a nuclear steam generator for mechanically removing contamination from the inside of the heat exchange tube by contacting the inside of the tube. However, the Smith, et al. patent does not appear to disclose a system and method for decontaminating the inside surface of a tube using a dry abrasive grit and/or a liquid under pressure.

A device for mechanically cleaning instrumentation guide tubes using water under pressure is disclosed by U.S. Pat. No. 4,720,369 issued Jan. 19,1988, in the name of Gerard Cadaureille, et al. entitled "Device For Cleaning The Guide Tubes Of The Means of Measuring Neutron Fluxes in a Pressurized-Water Nuclear Reactor". The Cadaureille, et al. patent discloses a device for cleaning the instrumentation guide tubes of a pressurized-water nuclear reactor, comprising a pump for injecting demineralized water under pressure in the tubes to remove solid particles and an assembly for recovering the radioactive waste. Although the Cadaureille, et al. patent discloses a device for cleaning instrumentation guide tubes, the Cadaureille, et al. patent does not appear to disclose a system and method using a liquid-abrasive grit cleaning composition under pressure to clean the inside surface of the tube. Moreover, the Cadaureille, et al. patent does not appear to contemplate a system and method including seal means for confining the liquid-abrasive grit composition to a predetermined portion of the inside surface of the tube so that substantially all of the solid particles can be removed from the tube.

An apparatus for mechanically cleaning a pipe using a scraping device and a mixed flow of compressed air and abrasive material is disclosed by U.S. Pat. No. 4,622,709 issued Nov. 18, 1986, in the name of Shinichi Matsuda entitled "Cleaning Apparatus For Pipes". The Matsuda patent discloses a cleaning apparatus for a pipe which comprises at least one scraping device and a grinding device which is connected behind the scraping device. The scraping device has scraping segments which have scraping portions able to contact the inner surface of the pipe for removing deposits. The grinding device is provided for removing deposits which have not been removed by the scraping portions. The grinding device includes a rotatable ejection pipe terminating in a nozzle which ejects a mixed flow of compressed air and abrasive material such as sand, etc. for removing deposits; thus, the Matsuda patent does not appear to contemplate use of a liquid-abrasive grit composition to decontaminate the inner surface of the pipe. Further, although the Matsuda patent discloses a cleaning apparatus for pipes, the Matsuda patent appears to require both ends of the pipe to be accessible; thus, the Matsuda apparatus appears incapable of being used as intended when only one end of the pipe is accessible, such as is the case during the typical nuclear steam generator replacement. Moreover, although the Matsuda patent may disclose a scraping device and a grinding device for removing deposits from the inside surface of a pipe, the Matsuda patent does not appear to disclose seal means disposed near the scraping device and grinding device for suitably confining the removed deposits and abrasive grit material to a predetermined portion of the inside surface of the pipe so that substantially all of the deposits and abrasive grit material can be removed from the surface after the cleaning operation.

A sand-blasting and vacuum apparatus is disclosed by U.S. Pat. No. 4,333,277 issued June 8, 1982, in the name of Robert T. Tasedan entitled "Combination Sand-blasting and Vacuum Apparatus". The Tasedan patent discloses a sand-blasting apparatus which is operated by a vacuum system, wherein there is provided a sand-blasting gun having an air-inlet passage and a sand-inlet passage. Air is discharged into a mixing chamber, creating a vacuum therein to suck sand through the sand-inlet passage, and to discharge the sand through a nozzle under high-velocity so as to impinge against the work surface to be sanded. The sand is captured within the enclosed discharge end of the gun and then returned to the sand-storage tank. According to this patent, the sand is captured by a cup-like housing formed from resilient material provided with a resilient annular-seal member to be pressed against the work surface for capturing used sand and for allowing the used sand to be sucked back to the sand-storage tank. Although the Tasedan patent discloses a sand-blasting apparatus, the Tasedan patent does not appear to contemplate use of a liquid-abrasive grit composition for cleaning the work surface. Moreover, although the Tasedan patent discloses a cup-like housing provided with a resilient annular-seal member to be pressed against the work surface, the Tasedan patent does not appear to disclose seal means engaging the entire periphery of the inside surface of a pipe for confining a liquid-abrasive grit composition to a predetermined portion of the inside surface of the pipe.

Consequently, although the patents recited hereinabove disclose various apparatus and a method for cleaning the inner surface of tubular members, these patents do not appear to disclose a system and method for abrading radioactive contaminates from the inside surface of a tubular member, wherein the system includes suitable seal means for confining the abrasive cleaning composition and removed deposits to a predetermined portion of the inside surface of the tubular member so that substantially all of the contaminants and cleaning composition can be removed from the surface after the cleaning operation.

Therefore, what is needed is a system and a method for abrading radioactive contaminants from the inside surface of a tubular member, wherein the system includes suitable seal means for confining a liquid-abrasive grit cleaning composition and contaminants to a predetermined portion of the inside surface of the tubular member so that substantially all of the contaminants and cleaning composition can be removed from the surface after the cleaning operation.

SUMMARY OF THE INVENTION

Disclosed herein are a system and a method for abrading radioactive contaminants from the inside surface of a pipe. The system includes a nozzle block capable of mixing a liquid and an abrasive grit into a suitable liquid-abrasive grit cleaning composition and impinging the cleaning composition against the inside surface of the pipe to clean the pipe. The system further includes an inflatable torus-shaped seal for confining the liquid-abrasive grit cleaning composition and abraded contaminants to a predetermined portion of the inside surface of the pipe so that substantially all of the contaminants and cleaning composition can be vacuumed from the surface.

An object of the invention is to provide a system for cleaning the inside surface of a tubular member, comprising cleaning means capable of being positioned in the tubular member for dispensing a cleaning composition onto the inside surface of the tubular member to clean the inside surface of the tubular member.

Another object of the invention is to provide-a system for cleaning the inside surface of a tubular member, comprising seal means capable of being disposed near the cleaning means and capable of contacting the inside surface of the tubular member for confining the cleaning composition to a predetermined portion of the inside surface of the tubular member.

Yet another object of the invention is to provide a system for cleaning the inside surface of a tubular member, further comprising alignment means connected to the cleaning means for aligning the cleaning means along the longitudinal axis of the tubular member.

A further object of the invention is to provide a method for abrading contaminants from the inside surface of a pipe having an open end, the method comprising the steps of positioning cleaning means in the pipe for spraying a cleaning composition under pressure against the inside surface of the pipe to abrade the contaminants from the inside surface of the pipe, positioning inflatable seal means in the pipe for sealably engaging the inside surface of the pipe to confine the cleaning composition and abraded contaminants to a predetermined portion of the inside surface of the pipe, inflating the seal means into intimate sealing engagement with the periphery of the inside surface of the pipe, and engaging alignment means with the inside surface of the pipe for stabilizing the cleaning means in the pipe and for aligning the cleaning means parallel to the longitudinal axis of the pipe.

Another object of the invention is to provide a method for abrading contaminants from the inside surface of a pipe having an open end, the method comprising rinsing the inside surface of the pipe to wash residual cleaning composition and abraded contaminants from the inside surface of the pipe.

These and other objects of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings wherein there is shown and described illustrative embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter of the invention, it is believed the invention will be better understood from the following description, taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a view in partial vertical section of a nuclear steam generator with parts removed for clarity;

FIG. 2 illustrates an operator standing on a workman's platform in position to clean a steam generator inlet pipe after the steam generator has been removed;

FIG. 3 is a view in partial vertical section of a steam generator pipe and of the system of the invention in operative condition to clean the pipe;

FIG. 4 is a view of a plurality of conduits in horizontal section taken along section IV—IV of FIG. 3;

FIG. 5 is a perspective view of an inflatable torus-shaped seal;

FIG. 6 is a view in partial vertical section of the inflatable seal disposed in the pipe and of a fixture disposed in the pipe for abrading the inside surface of the pipe;

FIG. 7 is a view of the fixture disposed in the pipe taken along section VII—VII of FIG. 6;

FIG. 8 is a perspective view of the fixture;

FIG. 9 is a perspective view in vertical section of the fixture;

FIG. 10 is a view in vertical section of a pneumatic brace assembly connected to the fixture;

FIG. 11 is a view in vertical section of a spring-biased brace assembly connected to the fixture; and

FIG. 12 is a view in vertical section of a motor-operated brace assembly connected to the fixture.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Replacing a nuclear steam generator requires severing the end of the piping connected thereto and removing the steam generator. After the steam generator is removed, the radiation field emitted through the exposed pipe stubs due to radioactive sediments on the inside surface of the piping may expose maintenance workers to an undesirable level of radiation. Cleaning of the highly radioactive sediments from the inside surfaces of the piping, particularly from the inside surface of the piping near the pipe stubs, will reduce the radiation exposure to maintenance workers performing the steam generator replacement. Disclosed herein is a system and a method for abrading radioactive contaminants from the inside surface of pipes.

Referring to FIG. 1, there is illustrated a vertical nuclear heat exchanger or steam generator, generally referred to as 10, for producing steam (not shown). The steam generator includes a generally cylindrical shell 20 having a lower portion 30 and an upper portion 40. The lower portion 30 includes a hemispherical channel head 45. Surrounding shell 20 is a horizontal operating floor 50 providing means for routine access to steam generator 10. Steam generator 10 further includes a feedwater line 60 connected to upper portion 40 for supplying feedwater (not shown) to the interior of shell 20, which feedwater is ultimately converted to steam in the manner described hereinbelow. Also connected to upper portion 40 is a main steam line 70 for conducting the steam out of steam generator 10. Moreover, disposed in shell 20 is a vertical tube bundle, generally referred to as 80, comprising a plurality of vertical, inverted U-shaped steam generator tubes 90. Disposed at various locations along the length of bundle 80 are a plurality of horizontal tube support plates 100 having holes therein for receiving each tube 90. Disposed in lower portion 30 and below the bottom-most support plate is a horizontal tube sheet 110 having a plurality of vertical apertures therethrough for receiving the ends of tubes 90. Disposed in channel head 45 is a vertical, semi-circular divider plate 120 for dividing channel head 45 into an inlet plenum chamber 130 and an outlet plenum chamber 140. Connected to channel head 45 is an inlet pipe 150 containing radioactive reactor coolant or liquid moderator (not shown) heated by a nuclear reactor (not shown). As illustrated in FIG. 1, the inlet pipe 150 has a reactor coolant pump 160 associated therewith for pumping the liquid moderator through steam generator 10. Inlet pipe 150 has a first end 170 in fluid communication with inlet plenum chamber 130 for conducting the radioactive moderator into inlet plenum chamber 130. Inlet pipe 150 also has a second end (not shown) connected to other equipment in the power plant. Moreover, connected to channel head 45 is an outlet pipe 180. Outlet pipe 180 has a first end 190 in fluid communication with outlet plenum chamber 140 for conducting the radioactive moderator out of outlet plenum chamber 140. Outlet pipe 180 also has a second end (not shown) connected to other equipment in the power plant. During operation of steam generator 10, the liquid moderator enters inlet plenum chamber 130 through inlet pipe 150 and flows through tubes 90 to outlet plenum chamber 140 where the moderator exits steam generator 10 through outlet pipe 180. As the moderator travels through tubes 90, it releases its heat to the feedwater which enters upper portion 40 through feedwater line 60 and which flows downwardly until it is in fluid communication with tube bundle 80 and tube sheet 110. As the feedwater receives the heat through tubes 90 from the moderator, the feedwater boils and vaporizes into steam which exits steam generator 10 through main steam line 70. The steam is ultimately transported to a turbine-generator for generating electricity in a manner well known in the art. However, it may be necessary to plug some tubes 90 that may have developed leaks during operation of steam generator 10. If it becomes necessary to plug more than a reasonable number of such tubes, it may be necessary to replace steam generator 10.

Turning now to FIGS. 2 and 3, steam generator 10 will have been removed by severing the piping connected thereto. In this regard, inlet pipe 150 and outlet pipe 180 have been severed or cut-through near first ends 170 and 190 where pipes 150 and 180 are connected to steam generator 10. Severing of inlet pipe 150 and outlet pipe 180 will create inlet pipe stub 200 and outlet pipe stub 210, which pipe stubs 200 and 210 will allow an inside surface 220 of inlet pipe 150 or outlet pipe **180** to be accessible for decontamination. As stated hereinabove, suitably decontaminating inlet pipe **150** or outlet pipe **180** will reduce the radiation dosage to maintenance personnel to a level as low as reasonably achievable. As shown in FIG. **2**, a workman's platform **230** may be positioned near the pipe (e.g., inlet pipe **150** or outlet pipe **180**) to be decontaminated for supporting an operator **240** who will operate a decontamination system for decontaminating inside surface **220** of inlet pipe **150** or outlet pipe **180**.

Referring to FIGS. **3** and **4**, there is illustrated a system, generally referred to as **250**, for decontaminating inside surface **220** of a tubular member or pipe (e.g., inlet pipe **150** or outlet pipe **180**). System **250** comprises covering means, generally referred to as **260**, connected to inlet pipe stub **200** or outlet pipe stub **210** for substantially covering inlet pipe stub **200** or outlet pipe stub **210** to reduce radiation dosage to operator **240** and to reduce the risk that the contaminants removed from surface **220** will become airborne in the atmosphere external to pipe **150** and **180**. Covering means **260**, which may be rubber or the like, comprises an expandable and flexible boot or cover plate **270** having a generally disk-shaped portion **280** for covering an open end **290** defined by inlet pipe stub **200** or outlet pipe stub **210**. Cover plate **270** is expandable and flexible so that it can be adjusted to pipe stubs having different outside diameters. Disk-shaped portion **280** includes an annular first flange **300** depending therefrom for surrounding inlet pipe stub **200** or outlet pipe stub **210** so that cover plate **270** can be temporarily affixed to inlet pipe stub **200** or outlet pipe stub **210** as described more fully hereinbelow. Disk-shaped portion **280** may also include an annular second flange **310** extending outwardly therefrom, which second flange **310** defines a first aperture **320** for receiving a generally tubular flexible housing **330** therethrough. Housing **330**, which may be a suitable plastic or the like, is flexible so that it is capable of bending to the contour of inlet pipe **150** or outlet pipe **180**. Housing **330** has a housing first end portion **340** connected to rotation means, such as a wheel **350**, for rotating tubular housing **330** about its longitudinal axis, as described more fully hereinbelow. As described in more detail hereinbelow, housing **330** also has a housing second end portion **360** connected to cleaning means, such as a decontamination fixture assembly, generally referred to as **370**, for cleaning inside surface **220**, which fixture assembly **370** is capable of being disposed in inlet pipe **150** or outlet pipe **180**. Disk-shaped portion **280** further defines a second aperture **380** for receiving a flexible, generally tubular suction line **390** therethrough. Suction line **390**, which may be high strength rubber or the like, has one end connected to suction means, such as vacuum pump **400**, for applying a vacuum or suction to suction line **390**. Moreover, suction line **390** has another end connected to a suction head **410** for vacuuming or suctioning contaminants (not shown) abraded from inside surface **200** and for vacuuming or suctioning liquid (not shown), and/or abrasive grit (not shown) from inside surface **220**. Disk-shaped portion **280** also defines a third aperture **420** for receiving a flexible, generally tubular first gas line **430** therethrough. First gas line **430**, which may be high strength rubber or the like, has one end connected to a first gas reservoir **440** for supplying a first gas (not shown), such as air or nitrogen or the like, to first gas line **430**. First gas line **430** has another end thereof connected to seal means, such as an inflatable dam assembly generally referred to as **450**, for confining a cleaning composition (e.g., liquid and/or abrasive grit) and abraded contaminates to a predetermined portion of inside surface **220**. It is important that the cleaning composition and abraded contaminants are confined and do not migrate through pipe **150** or pipe **180** to other plant equipment because the cleaning composition and abraded contaminants may cause damage to that other equipment. As described more fully hereinbelow, dam assembly **450** is inflatable for sealingly matingly contacting or engaging substantially the periphery of inside surface **220**. In this regard, it is important that dam assembly **450** be inflatable for sealingly engaging substantially the entire periphery of inside surface **220** so that abraded contaminates and cleaning composition do not migrate through inlet pipe **150** or outlet pipe **180** to other plant equipment where such abraded contaminates and cleaning composition may contaminate and damage the other plant equipment. It is also important that dam assembly **450** be inflatable for expandably sealingly engaging pipes of different inside diameters.

Again referring to FIGS. **3** and **4**, disk-shaped portion **280** may also include a fourth aperture **460**, which may be generally rectangular, for receiving viewing means, such as window assembly **470**, to view the progress of the decontamination process. Window assembly **470** includes a removable transparent pane **480**, which may be high-impact glass resistant to inadvertent breakage, for viewing the progress of the decontamination process. Moreover, it is important that pane **480** be removable because removing pane **480** allows operator **240** access to the inside of inlet pipe **150** or outlet pipe **180** for suitable adjustment and maintenance of fixture assembly **370** in inlet pipe **150** or outlet pipe **180**. Disk-shaped portion **280** may further include a fifth aperture **490** for receiving a second gas line **500** therethrough, which second gas line **500** is connected at one end thereof to a second gas reservoir **510** for supplying a second gas (not shown), which may be air or nitrogen or the like, to second gas line **500**. Second gas line **500** is connected at another end thereof to alignment means, which may be an adjustable brace assembly generally referred to as **520** connected to fixture assembly **370**, for aligning fixture assembly **370** along the longitudinal axis of inlet pipe **150** or outlet pipe **180**, as described more fully hereinbelow. It is important that brace assembly **520** be adjustable so that brace assembly **520** can adjust fixture assembly **370** to pipes having different inside diameters. Moreover, extending around first flange **300** is an adjustable bendable band or clamp **530** having an adjustable fastener **540** connected thereto for temporarily affixing cover plate **270** to inlet pipe stub **200** or to outlet pipe stub **210**.

Still referring to FIGS. **3** and **4**, a plurality of tubes collectively referred to as **550** extend through tubular housing **330** for conducting liquid and/or abrasive grit therethrough to fixture assembly **370**. Preselected tubes, such as first tube **560** and second tube **570**, have one end thereof in fluid communication with a liquid reservoir **580** containing a suitable liquid such as water, for supplying liquid under pressure to first tube **560** and second tube **570**. First tube **560** and second tube **570** each has another end thereof connected to fixture assembly **370** for supplying the liquid to fixture assembly **370**. Other preselected tubes, such as third tube **590** and a fourth tube **600**, have one end thereof connected to an abrasive grit reservoir containing a suitable dry abrasive grit, such as magnetite, aluminum oxide or boron trioxide, for supplying abrasive grit under pressure to third tube **590** and fourth tube **600**. Third tube **590** and fourth tube **600** each has another end thereof connected to fixture assembly **370** for supplying the abrasive grit to fixture assembly **370**. Connected to third tube **590** and to fourth tube **600** may be first valve **620** and second valve **630**, respectively. First valve **620** and second valve **630** are capable of opening and closing for opening tubes **590** and **600** so that abrasive grit can be supplied to fixture assembly **370** and for closing tubes **590** and **600** so that abrasive grit will not be supplied to fixture assembly **370**. As described more fully hereinbelow, closing valves **620** and **630** will allow only liquid to be supplied to fixture assembly **370** for rinsing inside surface **220** after inside surface **220** has been abraded with the liquid-abrasive cleaning composition.

Referring now to FIGS. **5** and **6**, dam assembly **450** comprises at least a first inflatable bladder **640**, which may be rubber or the like, capable of expanding into sealing engagement with inside surface **220**. In the preferred embodiment of the invention, dam assembly **450** may further comprise a second inflatable bladder **650**. As illustrated in FIGS. **5** and **6**, bladders **640** and **650** are torus-shaped for matingly sealingly engaging inside surface **220** of pipe **150** or pipe **180**. Each bladder **640** and **650** defines a cavity **660** therein for inflating bladders **640** and **650**. Moreover, each bladder **640** and **650** further defines a central hole **670** for receiving a generally cylindrical gas manifold **680** therethrough. Gas manifold **680** defines a compartment **690** for receiving gas therein. Gas manifold **680** also defines a gas passage **700** in communication with compartment **690** and with cavity **660**. First bladder **640** and second bladder **650** are each attached, on the outboard side thereof, to a first end plate **710** and to a second end plate **720**, respectively. Bladders **640** and **650** may be attached to end plates **710** and **720** and to gas manifold **680** by a suitable adhesive. First end plate **710** defines a bore **730** therethrough in communication with compartment **690** for supplying gas to compartment **690**. Suitably connected to bore **730** is first gas line **430** for supplying gas to bore **730** so that bladders **640** and **650** may be inflated. First end plate **710** and second end plate **720** are attached, such as by welding, to opposite ends of gas manifold **680**.

As best seen in FIGS. **3**, **6**, **7**, **8**, and **9**, fixture assembly **370** is capable of being disposed in pipe **150** or pipe **180** by inserting it through open end **290**. Fixture assembly **370** comprises a hollow first cylinder **740** having an open first end portion **750** which may in turn have internal threads **760**. First cylinder **740** also has a second end portion **770** defining a first hole **780** and a second hole **790** therethrough. As shown in FIG. **9**, first hole **780** receives the end of fourth tube **600** therethrough and second hole **790** receives the end of first tube **560**. The ends of fourth tube **600** and first tube **560** may be affixed in first hole **780** and second hole **790** by a suitable adhesive. Similarly, second tube **570** and third tube **590** are attached to other holes (not shown) corresponding to holes **780** and **790** formed through first cylinder **740**. Threadably connected to first cylinder **740** is the housing second end portion **360** which is externally threaded for threadably engaging the threads **760**. Housing **330** is thus connected to first cylinder **740** so that as housing **330** is rotated about its longitudinal axis, first cylinder **740** will also simultaneously rotate about its longitudinal axis. Second end portion **360** also includes a pin **800** integrally attached thereto and extending therefrom for reasons to be described presently. Surrounding first cylinder **740** is a second cylinder **810** having a circumferential groove **820** circumscribing the inner surface of second cylinder **810**. Pin **800** which extends from second end portion **360** of housing **330** slidably matingly engages groove **820** so that housing **330** and first cylinder **740** are capable of rotating as rotational movement of second cylinder **810** is restricted. Alternatively, pin **800** may be a raised rail-shaped member integrally formed with housing **330** and extending around the circumference of second end portion **360** for slidably matingly engaging groove **820**.

Still referring to FIGS. **3**, **6**, **7**, **8**, and **9**, attached to first cylinder **740** is a nozzle block assembly, generally referred to as **830**, for spraying the liquid-abrasive grit composition under pressure against inside surface **220** so that inside surface **220** can be decontaminated. Nozzle block assembly **830** comprises a generally cylindrical outer nozzle **840** having a first end integrally attached to first cylinder **740** and having an open second end **850** for exit of liquid under pressure. Outer nozzle **840** defines a longitudinal first channel **860** therethrough, which first channel **860** is in communication with second hole **790** for conducting liquid from first tube **560**, into first channel **860**, and out second end **850**. Disposed in first channel **860** is a generally cylindrical inner nozzle **870** having a first end integrally attached to first cylinder **740** and having an open second end **880** for exit of abrasive grit under pressure. Second end **880** may be frusto-conical for reasons described thereinbelow. Inner nozzle **870** defines a longitudinal second channel **890** therethrough, which second channel **890** is in communication with first hole **780** for conducting abrasive grit from fourth tube **600**, into second channel **890**, and out second end **880**. It will be understood that as the liquid exits outer nozzle **840** under pressure and as the abrasive grit exits inner nozzle **870** under pressure, the liquid and the abrasive grit will mix or combine to form a liquid-abrasive grit composition which will then impinge inside surface **220** for decontaminating inside surface **220**. In this regard, the frusto-conical shape of end **880** will distribute the exit flow of the abrasive grit such that it will sufficiently mix with the liquid at a predetermined distance beyond the end of the nozzle block **830**. Moreover, integrally attached to second cylinder **810** and extending outwardly therefrom is at least one leg **900** having a roller member **910** connected to the end thereof. Leg **900** assists in supporting fixture **370** in pipe **150** or **180**. Roller member **910** also enables fixture **370** to be rolled along inside surface **220**.

With particular reference to FIGS. **10**, **11**, and **12**, brace assembly **520** comprises a generally cylindrical body portion **920** having a first end **930** and a second end **940**. Body portion **920** defines a chamber **950** for slidably receiving a piston **960** having a first end portion **970** and a second end portion **980**. Body portion **290** also defines a bore **985** of diameter smaller than the diameter of chamber **950** for receiving second end portion **980** therethrough. First end portion **970** is disposed in chamber **950** and second end portion **980** extends through bore **985** and beyond first end **930** of body portion **920**. Second end **940** of body portion **920** is connected to second cylinder **810** via connector **987**. Integrally attached to the end of second end portion **980** is a generally hemispherical-shaped brace pad **990** for engaging inside surface **220** to stabilize fixture assembly **370** in pipe **150** or pipe **180**. In the preferred embodiment, an end of second gas line **500** is in communication with chamber **950** for supplying the second gas to chamber **950**. It will be understood that when the second gas is supplied to chamber **950** the gas will exert a force against first end portion **970** for biasing or translating piston **960**, and the brace pad **990** attached thereto, outwardly to engage inside surface **220**. A vacuum pump **995** may be connected to second gas line **500** for producing a vacuum in chamber **950** so that piston **960** will disengage from surface **220**. Thus, brace assembly **520** may be a pneumatic (e.g., gas-activated) brace for engaging brace pad **990** into and disengaging brace pad **990** from inside surface **220**. Alternatively, brace assembly **520** may be mechanical (see FIG. **11**) as described immediately hereinbelow. As shown in FIG. **11**, interposed between second end **940** and first end portion **970** may be a spring **1000** for biasing or translating piston **960**, and the brace pad **990** attached thereto, outwardly to engage inside surface **220**. On the other hand, brace assembly **520** may be electrically operated by a suitable motor (see FIG. **12**). As shown in FIG. **12**, disposed in chamber **950** may be an electric motor **1010** in electromagnetic communication with first end portion **970** for biasing or translating piston **960**, and the brace pad **990** attached thereto, into engagement with and disengagement from inside surface **220**. Biasing brace pad **990** into engagement with inside surface **220** stabilizes fixture **370** in pipe **150** or **180**. It will be understood that brace assembly **520** allows fixture **370** to be stabilized in pipes having different inside diameters.

METHOD OF OPERATION

To clean the inside surface of a pipe, such as inlet pipe **150** or outlet pipe **180**, inflatable dam assembly **450** is inserted, preferably in a deflated condition, through open end **290** of inlet pipe **150** or outlet pipe **180**. Dam assembly **450** may be positioned in pipe **150** or pipe **180** by any suitable means, such as by a flexible elongated pole (not shown) capable of pushing cam assembly **450** along inside surface **220**. When dam assembly **450** is suitably positioned a predetermined distance beyond the location where decontamination of inside surface **220** is desired, the first gas is supplied to first gas line **430**. The first gas flows through first gas line **430**, through bore **730** and into compartment **690** which is formed in dam assembly **450**. The first gas then flows from compartment **690**, through gas passage **700** and into cavity **660** for inflating first bladder **640** and second bladder **650** into sealing engagement with inside surface **220**. First bladder **640** and second bladder **650** may be inflated to a pressure of approximately 75 pounds per square inch (psi) to suitably engage the inner diameter of pipe **150** or **180**, which inner diameter may be between approximately 29 inches and 31 inches in the case of the typical pressurized water reactor nuclear steam generator. First bladder **640** should confine the abraded contaminants and cleaning composition to the area of inside surface **220** that is between first bladder **640** and open end **290**. However, should first bladder **640** not contain the abraded contaminants and cleaning composition to the predetermined area, then second bladder **650** will function as a redundant second barrier for containing the abraded contaminants and cleaning composition to the area of inside surface **220** designated for decontamination. In this manner, abraded contaminants and cleaning composition will not migrate beyond second bladder **650** to contaminate and damage plant equipment that may be connected to inlet pipe **150** or outlet pipe **180**. Each bladder **640** or **650** is circular and torus-shaped for matingly sealingly engaging the circular periphery of inside surface **220**. It will be appreciated that the unitary structure of dam assembly **450** allows it to be rapidly installed and removed.

Fixture assembly **370**, with housing **330** connected thereto, is positioned near the area of inside surface **220** where decontamination is to begin. Fixture assembly **370** may be positioned in pipe **150** or pipe **180** by moving housing **330** into pipe **150** or pipe **186**. Moving housing **330** will allow fixture assembly **370** to roll along inside surface **220** on roller member **910**. When fixture assembly **370** reaches the area of inside surface **220** to be decontaminated, the second gas is caused to flow into second gas line **500** for pressurizing chamber **950** formed in brace assembly **520**. Pressurizing chamber **950** will cause piston **960** to move outwardly toward inside surface **220** to engage brace pad **990** with inside surface **220**. When brace pad **990** engages inside surface **220**, fixture assembly **370** will be stabilized in pipe **150** or pipe **180** so that fixture assembly **370** will not substantially move when operated. Moreover, when brace pad **990** engages inside surface **220**, fixture assembly **370** will also be substantially aligned with the longitudinal axis of pipe **150** or pipe **180**. As described hereinabove, brace assembly **520** may be gas-activated, motor-activated or spring-activated for biasing brace pad **990** into engagement with inside surface. It is important that fixture assembly **370** be stabilized and substantially aligned with respect to the longitudinal axis of the pipe so that second end **850** of outer nozzle **840** and second end **880** of inner nozzle **870** will always be spaced a predetermined distance from inside surface **220** to provide sufficient space for the suitable mixing of the abrasive grit and liquid after the abrasive grit and liquid exit nozzle block **830**.

It is important that the contaminants abraded from inside surface **220** not escape through open end **290** of pipe **150** or **180** and become airborne in the atmosphere external to pipe **150** and **180**. If the abraded contaminants were to travel out open end **290** and become airborne, then the atmosphere external to pipe **150** and **180** would become radioactively contaminated. To reduce the risk of such contamination, boot **260** is placed on outlet pipe stub **200** or inlet pipe stub **210** such that cover plate **70** covers open end **290** for reducing radiation dosage to operator **240** and for reducing the risk that abraded contaminants and cleaning composition will inadvertently migrate through open end **290** and become air-borne. Boot **260** is preferably expandable for fitting pipe stubs of different diameters. When boot **260** is properly fitted on pipe stub **200** or **210**, depending first flange **300** will surround pipe stub **200** or **210**. Clamp **530** is placed around first flange **300** and pipe stub **200** or **210** and tightened thereagainst by tightening fastener **540**. In this manner boot **260** is removably affixed to outlet pipe stub **200** or inlet pipe stub **210**. Moreover, removable window **390** can be temporarily removed to finally adjust the positions of fixture assembly **370** and/or dam assembly **450** in pipe **150** or **180**. Window **390** is replaced prior to commencing the decontamination operation.

To begin the decontamination operation, liquid under pressure is caused to flow from liquid reservoir **580** into first tube **560** and second tube **570**, which liquid then flows through first tube **560** and second tube **570** to first channel **860**. Abrasive grit, such as boron trioxide, is caused to flow under pressure from abrasive grit reservoir **610** into third tube **590** and fourth tube **600**, which abrasive grit then flows through third tube 590 and fourth tube 600 to second channel 890. As the liquid exits first channel 860, the liquid will intermix and combine with the abrasive grit exiting second channel 890. This combination of liquid and abrasive grit forms the cleaning composition that will abrade the contaminants from inside surface 220. It is contemplated that one decontamination pass along surface 220 will use the cleaning composition to decontaminate inside surface 220 and a second pass will use only water to rinse or wash residual cleaning composition and contaminates from inside surface 220. During the second pass, valves 620 and 630 are closed thereby stopping the flow of abrasive grit to fixture assembly 370 as the flow of liquid (e.g., water) continues to flow from liquid reservoir 580 to fixture assembly 370. Of course, the cleaning process may be repeated by performing additional cleaning passes to remove contamination when the contamination is strongly bonded to inside surface 220.

As the cleaning composition impinges inside surface 220, wheel 350 is rotated. Wheel 350 may be rotated manually by operator 240. Alternatively, wheel 240 may be rotated by suitable motor means such as a reversible motor (not shown). Because wheel 350 is attached to housing first end portion 340, housing 330 will rotate as wheel 350 rotates. Moreover, because housing second end portion 360 threadably engages first end portion 750 of first cylinder 740, first cylinder 740 will rotate as housing 330 rotates. It will be understood that second cylinder 810 will not rotate when housing 330 rotates because pin 800 will slide in groove 820 formed in second cylinder 810. At least one nozzle block 830 is attached to first cylinder 740; therefore, as first cylinder 740 rotates, nozzle block 830 will rotate in a 360 degree circle about the axis of rotation coinciding with the longitudinal axis of first cylinder 740. Rotation of nozzle block 830 in the manner described hereinabove, will allow the cleaning composition to impinge the entire periphery of inside surface 220.

A reactive force will be experienced by fixture assembly 370 as the cleaning composition, which is under pressure, exits nozzle block 830. This reactive force will be opposite and substantially equal to the force with which the cleaning composition impinges inside surface 220. The reactive force will tend to destabilize and vibrate fixture assembly 370 to such an extent that the predetermined distance between the ends 840/880 of nozzle block 830 and inside surface 220 might not be maintained. Maintaining the predetermined distance between the ends 840/880 of nozzle block 830 and inside surface 220 assists in ensuring that sufficient space will exist for suitable mixing of the abrasive grit and liquid when the abrasive grit and liquid exit nozzle block 830. In this regard, when fixture assembly 370 is positioned at the location where decontamination is to occur a second gas is caused to flow from second gas reservoir to second gas line 500. The second gas then enters chamber 950 for moving piston 960 toward inside surface 220 until brace pad 990 intimately engages inside surface 220 for stabilizing fixture assembly 370. In the preferred embodiment, engaging brace pad 990 with inside surface 220 creates three points of contact between fixture assembly 370 and inside surface 220. That is, fixture assembly 370 will contact inside 220 at each of the two roller members 910 and at brace pad 990 for stabilizing fixture assembly 370 It will be understood that brace pad 990 may be disengaged from inside surface 220 by stopping the flow of the second gas into chamber 950 and then operating vacuum pump 995 to create a vacuum in chamber 950. Of course, brace pad 990 need not be pneumatically operated. Brace pad 990 may be spring-biased or may be operated by an electric motor.

During operation of steam generator 10, which operation is described hereinabove, the radioactive water moderator and the metallic surface of pipes 150 and 180 chemically react over time to form a radioactive oxide film corrosion product or contaminant on inside surface 220. According to this invention, suitable liquid-abrasive grit can be used to abrade away the radioactive oxide film or contaminants from inside surface 220. It should be understood that a choice of abrasive grit is made on the basis of surface decontamination factor requirements, waste processing capabilities and limitations, and chemistry compatibility considerations. Typical abrasive grits are boron trioxide, magnetite, and alumina. In the case of water soluble boron trioxide, an achievable surface decontamination factor is between three and six, where the decontamination factor is defined as:

$$\text{Decontamination Factor} = \frac{\text{Surface initial radioactivity value}}{\text{Surface final radioactivity value}}$$

A decontamination factor between three and six is sufficient to reduce the radioactivity exposure of operator 240 to a level that is as low as reasonably achievable in this particular application.

The combination of abrasive grit and liquid (e.g., boron trioxide and water) may be selected such that a slurry cleaning composition is formed having approximately three to five percent solids by weight. For decontaminating the typical pressurized water reactor nuclear steam generator inlet or outlet pipe, the water may have a flow rate through each of the two nozzle blocks 830 of approximately 11 gallons per minute with a water pressure of approximately 4,000 pounds per square inch (psi). When boron trioxide is selected as the abrasive grit, the amount of waste water generated to decontaminate one foot length of inside surface 220 may be approximately 500 to 550 gallons if two passes are made across the area undergoing decontamination. The first pass will be for the abrasion phase of the decontamination and the second pass will be for rinsing the abraded area. Housing 330 may be operated to push fixture assembly 370 along inside surface 220 such that nozzle block 830 will travel along inside surface 220 at a speed of approximately three feet per minute during decontamination and at a speed of approximately 12 feet per minute during rinsing of inside surface 220. Nozzle blocks 830 should be rotated at a speed sufficient to cover the desired area of inside surface 220. The abrasive grit reservoir 610 will supply the abrasive grit such that the combined flow rate of the abrasive grit to both nozzle blocks 830 will total about three to four pounds mass per minute. Thus, in the preferred embodiment, each of the two nozzle blocks 830 will cause about one and one-half pounds mass per minute to two pounds mass per minute of abrasive grit to exit each nozzle block 830.

As stated hereinabove, following decontamination with the liquid-abrasive grit spray during the first pass, inside surface 220 is sprayed with high pressure water to flush residual grit from inside surface 220. This rinse cycle is performed during the second pass by repeating the sweep pattern without the addition of abrasive grit (e.g., closing first and second valves **620** and **630**) and by operating fixture assembly **370** at a higher speed (e.g., approximately 12 feet per minute).

Next, suction head **410** is positioned on inside surface **220** for vacuuming or suctioning abraded contaminants and cleaning composition from the abraded area. When vacuum pump **400** is operated, a partial vacuum is created in suction line **390**, which partial vacuum is also created in suction head **410**. Vacuum pump **400** may a diaphragm pump capable of attaining approximately 150 feet of head. The vacuum existing in suction head **410** will cause abraded contaminants and cleaning composition dispersed near suction head **410** to migrate into suction head **410** for removal from pipe **150** or pipe **180**. If desired, suction head **410**, which may be a commercially available suction head, may be positioned in pipe **150** or pipe **180** by the pole (not shown) referred to hereinabove. Suctioning of the abraded contaminants and cleaning composition from inside surface **220** may be performed after fixture assembly **370** has been retrieved from within pipe **150** or pipe **180**.

In the case of the typical pressurized water nuclear reactor steam generator inlet or outlet pipe, the decontamination will be performed on inside surface **220** for a length of approximately six feet beyond open end **290** of inlet pipe **150** or outlet pipe **180** or approximately three feet beyond the elbow portion of pipe **150** or pipe **180**, the pipe having an inside diameter between approximately 29 inches and 31 inches for the typical pressurized water reactor nuclear steam generator. Dam assembly **450** therefore may be installed at approximately six feet from open end **290**.

Of course, it will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention. Moreover, it should be further understood that the system and method described herein may be used to clean any tubular member and need not be limited to the decontamination of steam generator inlet and outlet piping. In addition, the system and method described herein need not be limited to cleaning radioactively contaminated surfaces; rather, the invention described herein may be used to clean non-radioactive surfaces of virtually any scale, film, incrustation or the like.

Therefore, what is provided is a system and method for abrading radioactive contaminants from the inside surface of a pipe, wherein the system includes suitable seal means for confining a liquid-abrasive grit cleaning composition to a predetermined portion of the inside surface of the pipe so that substantially all of the contaminants and cleaning composition can be removed from the surface.

What is claimed is:

1. A system for cleaning the inside surface of a tubular member, the tubular member defining a longitudinal axis therethrough, comprising:

(a) cleaning means capable of being positioned in the tubular member for displacing a cleaning composition onto the inside surface of the tubular member to clean the inside surface of the tubular member;

(c) inflatable seal means disposed to one side of said cleaning means, said inflatable seal means capable of contacting the inside surface of the tubular member for confining the cleaning composition to a predetermined portion of the inside surface of the tubular member, said seal means being positionable along the inside surface of the tubular member independently of said cleaning means; and

(c) an adjustable brace assembly connected to said cleaning means for stabilizing said cleaning means in the tubular member, for aligning said cleaning means along the longitudinal axis of the tubular member and for adjusting said cleaning means to tubular members having different inside diameters.

2. The system according to claim **1**, wherein said seal means is an inflatable dam assembly for expansibly sealably engaging the inside surface of the tubular member.

3. A system for the cleaning the inside surface of a pipe, the pipe defining a longitudinal axis therethrough, comprising:

(a) cleaning means capable of being positioned in the pipe for spraying a pressurized slurry against the inside surface of the pipe to clean contaminants from the inside surface of the pipe;

(b) inflatable seal means disposed to one side of said cleaning means for sealably contacting the inside surface of the pipe to confine the slurry to a predetermined portion of the inside surface of the pipe, said seal means being positionable along the inside surface of the pipe independently of said cleaning means; and

(c) an adjustable brace assembly connected to said cleaning means for stabilizing said cleaning means in the pipe and for aligning said cleaning means along the longitudinal axis of the pipe, said brace assembly defining a chamber therein.

4. The system according to claim **3**, wherein said seal means is an inflatable dam assembly for expansibly sealably engaging the inside surface of the pipe to confine the slurry and contaminants to the predetermined portion of the inside surface of the pipe.

5. The system according to claim **4**, wherein said brace assembly further comprises a piston having a first piston end portion disposed in the chamber defined by said brace assembly and having a second piston end portion capable of abutting the inside surface of the pipe for stabilizing said cleaning means in the pipe and for aligning said cleaning means along the longitudinal axis of the pipe.

6. The system according to claim **5**, further comprising means connected to said cleaning means for supplying the pressurized slurry to said cleaning means.

7. The system according to claim **6**, further comprising:

(a) suction means capable of being disposed on the inside surface of the pipe and near said cleaning means for suctioning the slurry from the inside surface of the pipe;

(b) a second gas line having one end in communication with a second gas reservoir and having another end in communication with the chamber for delivering the second gas to the chamber to bias said piston into intimate engagement with the inside surface of the pipe; and

(c) an electric motor disposed in the chamber proximate the second piston end portion for electromagnetically biasing the second piston end portion into intimate engagement with the inside surface of the pipe.

8. The system according to claim **7**, further comprising a spring disposed in the chamber and contacting the first piston end portion for biasing said piston into intimate engagement with the inside surface of the pipe.

9. A system for decontaminating the inside surface of a pipe, the pipe defining a longitudinal axis therethrough, the pipe having an open end, the inside surface having radioactive contaminants thereon, comprising:

(a) a fixture assembly capable of being inserted through the open end of the pipe and capable of being positioned in the pipe for spraying a pressurized water-grit slurry against the inside surface of the pipe to abrade the contaminants from the inside surface of the pipe;

(b) an inflatable dam assembly capable of being disposed in the pipe to one side of said fixture assembly for expansibly sealably engaging the inside surface of the pipe to confine the water-grit slurry and contaminants to a predetermined portion of the inside surface of the pipe, said dam assembly being positionable along the inside surface of the pipe independently of said fixture assembly; and

(c) an adjustable brace assembly connected to said fixture assembly for contacting the inside surface of the pipe to stabilize said fixture assembly in the pipe and to align said fixture parallel to the longitudinal axis of the pipe.

10. The system according to claim 9, wherein said dam assembly is an inflatable torus for matingly engaging the inside surface of the pipe.

11. The system according to claim 10, wherein said fixture assembly further comprises

(a) a rotatable hollow first cylinder defining a longitudinal axis therethrough, said first cylinder having an open first end and a second end portion having a first aperture and a second aperture formed through the second end portion

(b) a hollow generally cylindrical housing defining a longitudinal axis therethrough said housing extending into the open first end of said first cylinder, said housing attached to said first cylinder so that said first cylinder rotates about the longitudinal axis defined thereby;

(c) a second cylinder surrounding a portion of said first cylinder and connected to said brace assembly for supporting said brace assembly;

(d) a nozzle block connected to said first cylinder for spraying the water-grit mixture against the inside surface of the pipe, said nozzle block including:

(i) a generally cylindrical outer nozzle having a first end and a second end, the first end of said outer nozzle attached to said first cylinder, said outer nozzle defining a longitudinal first channel therethrough for passage of the water through the first channel and out the second end of said outer nozzle, the first channel in communication with the first aperture formed through the second end portion of said first cylinder; and

(ii) a generally cylindrical inner nozzle disposed in the first bore of said outer nozzle, said inner nozzle having a first end and a second end, the first end of said inner nozzle attached to said first cylinder and the second end of said inner nozzle terminating in a frusto-conical end portion for combining the grit and the water to form a water-grit slurry for abrading the contaminants from the inside surface of the pipe, said inner nozzle defining a longitudinal second channel therethrough for passage of the grit through the second channel and out the second end of said inner nozzle, the second channel in communication with the second aperture formed through the second end portion of said first cylinder.

12. The system according to claim 10, wherein said brace assembly has a body portion having a first end and a second end, said body portion defining a chamber therein, said body portion defining a bore extending from the chamber through the second end of said body portion.

13. The system according to claim 12, further comprising a piston having a first piston portion disposed through the bore and into the chamber and having a second piston end portion extending beyond the second end of said body portion.

14. The system according to claim 13, further comprising a brace assembly pad attached to the second piston end portion for engaging the inside surface of the pipe to stabilize the fixture assembly in the pipe.

15. The system according to claim 14, wherein said brace assembly pad is convex for matingly engaging the inside surface of the pipe.

* * * * *